

# Putt-Putt Steam Boat

## Conservation of Energy

### Introduction

Light a small candle inside a toy boat and watch it coast around the water while making a “putt putt” noise. Use this old-fashioned toy to illustrate how chemical energy is converted into mechanical energy as phase changes occur.

### Concepts

- Chemical energy
- Force and motion
- Phase changes

### Materials

|                                    |  |
|------------------------------------|--|
| Beaker, borosilicate, 1-L          | Pipet, disposable, small               |
| Bunsen burner                      | Putt-putt boat                         |
| Clamp, test tube                   | Stopper, one-hole (to fit test tube)   |
| Demonstration tray or water basin* | Support stand                          |
| Fuel candles for putt-putt boat    | Test tube, large (approximately 50 mL) |
| Glass tubing, 5 mm, 50 cm          | Tin candle holder                      |
| Glycerol, drops                    | Water, tap                             |
| Matches or lighter                 |  |

\*Large (must be able to sustain a depth of 3–4 cm of water)

### Safety Precautions

Use extreme care while working with an open flame. The boats get very hot. Do not allow students to touch the boats while they are in motion. Do not remove boats from the water until the flame has been extinguished and the boats have cooled for at least five minutes. Exercise caution when inserting glass tubing during follow-up demonstration. Use glycerol to lubricate the glass and wear protective gloves. Please follow all other normal laboratory safety procedures. Wash hands thoroughly with soap and water before leaving the laboratory. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

### Procedure

1. Fill the water basin to a depth of 3–4 cm with water.
2. Use the small pipet to fill one of the pipes in the rear of the boat with water until water comes out the other side (this indicates that the pipes and water tank are filled, see Figure 1).
3. Cover the pipes with your finger to keep the water from spilling and place the boat in the water basin.
4. Place a candle in the tin candle holder and light the candle while holding the end of the tin candle holder.
5. Place the candle holder inside the boat so that the flame is underneath the water tank (this is as far inside as the candle will go, see Figure 2).
6. Within a minute the boat will begin to make noise and move around the basin.

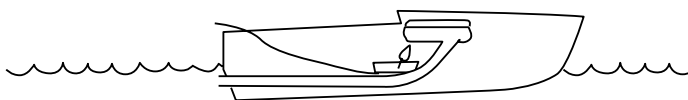


Figure 2.

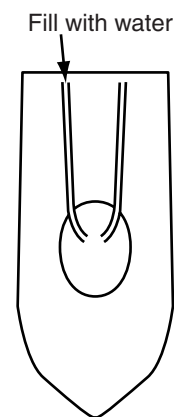


Figure 1.

### Part 2. Inside the Boat

1. Insert the glass tubing into the stopper until the tubing is within one cm of the bottom of the test tube. Use caution

when inserting glass tubing. Glycerol should be used to lubricate the glass. Wear protective gloves.

2. Clamp the test tube at an angle with the stopper-side down (towards the tabletop) and secure the clamp to a ring stand. Adjust the height of the test tube so that a Bunsen burner will fit underneath the rounded end (see Figure 3) and the tubing extends into the 1-L beaker.
3. Fill the 1-L beaker with water.
4. Remove the test tube from the clamp, remove the stopper and fill the test tube completely with water.
5. Stopper the test tube and use a pipet to fill the glass tubing with water.
6. Place a finger over the end of the glass tubing as the test tube assembly is repositioned in the clamp. Only release the end of the tubing when the end is submerged into the 1-L beaker filled with water.
7. Set up a Bunsen burner under the rounded end of the test tube.
8. Light the Bunsen burner and make sure the flame is heating the bottom of the tube.
9. After a minute or two the water above the flame will begin to boil. This will force water to spurt out of the glass tubing into the water dish.
10. The glass tube will momentarily fill with steam, which will quickly condense as it is cooled due to the surrounding water.
11. This will draw water from the dish back up into the rounded end of the test tube, and again the water will boil (see Figure 4).

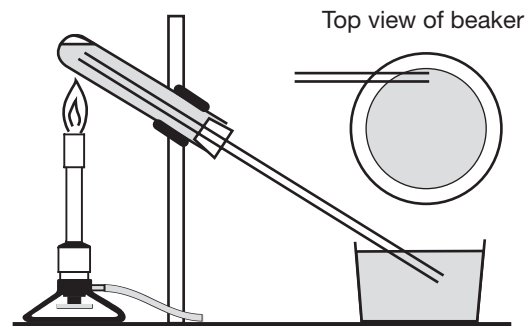


Figure 3.

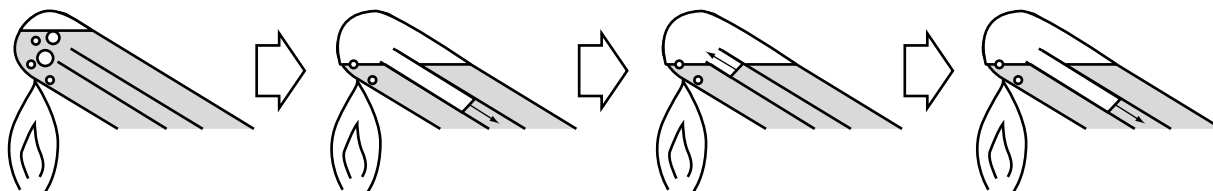


Figure 4.

12. Steps 9 and 10 will occur over and over in quick succession, making a noise similar to the putt-putt boats. The spurting out and sucking up of water from the beaker into the glass tubing will cause the water in the beaker to shift.

## Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Putt-putt boats may be reused many times. Dry off the boats after use to prevent rusting. Candle remains that have solidified may be thrown away in the trash.

## Discussion

The rapid-fire, putt-putt noise produced by the boat is the result of water spurting out and being sucked (or better, pushed) back into the “exhaust pipes” and into the water tank. The water tank is located directly above the flame on the inside of the boat. As the flame heats the tank, the water boils, forcing water out the back pipes as the molecules move more rapidly and spread out. The steam trapped in the pipes will condense as it is cooled by the water surrounding the pipes, resulting in cool water from the basin being drawn back up into the pipes and chamber. The water will again boil and the cycle will start over again. This cycle occurs over and over in rapid succession, causing the boat to move about. The erratic motions of the boat are due to unequal amounts of water spurting out of the two exhaust pipes. For example, if a larger amount of water shoots out of the left hand pipe, this will force the boat to move to the right, and vice versa. The boats are designed to utilize the energy produced as the phase of water changes from liquid to gas and back to liquid. The second procedure illustrates the phase changes occurring inside the boat in a clear tube for easier viewing.

## Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

***Unifying Concepts and Processes: Grades K–12***

Evidence, models, and explanation

Constancy, change, and measurement

***Content Standards: Grades 5–8***

Content Standard B: Physical Science, properties and changes of properties in matter, motions and forces, transfer of energy

***Content Standards: Grades 9–12***

Content Standard B: Physical Science, structure and properties of matter, chemical reactions, motions and forces, interactions of energy and matter

## Reference

Holdings, Bernie; *The Putt Putt Boats Science of Steamboats Instructor's Guide*; Higart Holdings: Everson WA, 2001.

## Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Putt-Putt Steam Boat* activity, presented by Penney Sconzo, is available in *Conservation of Energy*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

**Materials for *Putt-Putt Steam Boat* are available from Flinn Scientific, Inc.**

| Catalog No. | Description                                  |
|-------------|--|
| AP6746      | Putt Putt Boat                               |
| AP5429      | Demonstration Tray, Large                    |
| AP6763      | Fuel Candles, Pkg/6                          |
| GP9005      | Glass Tubing, Borosilicate Glass, 24" Length |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.